Navy M&S Management Office TIM

U.S. AIR FORCE

thetic Battlespace

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Overview

- Vision
- Development Approach
- Spring Experiment
- Summary

Vision

- **Provide:**
  - "Cradle to Grave" Systems Engineering Capability
  - Operationally Realistic C4ISR Environment to Immerse Operators With Engineers During Systems Analysis
  - Common Framework for Integrating Legacy and New Models and Simulations
  - Extension to Operations Community as Training and Course of Action Analysis Tool
- **Evolve Near Term to Support Joint Distributed Plant (JDEP) Track 3**
- **Support Future Major Air Force System Acquisition Challenges**
  - Multi-Sensor Command & Control Constellation (MC2C)
  - Space Based Radar (SBR)
  - Single Integrated Air Picture (SIAP)
  - ...

Development

JSB (SBA) Purpose

- **Provide Simulation Tool to Support Full Life Cycle Analysis of a Weapon System**
  - Concept Definition
  - Engineering & Development
  - Operations
  - Disposal
- **Key Capabilities**
  - Operationally Realistic
  - Physics-based (When Needed)
  - Variable Resolution and Fidelity
  - Execute in Real Time
  - Instrumented to Collect Data
  - Repeatable
  - Reconfigurable
  - Operator/Engineer Immersion
  - Configuration Controlled
  - Verified and Validated

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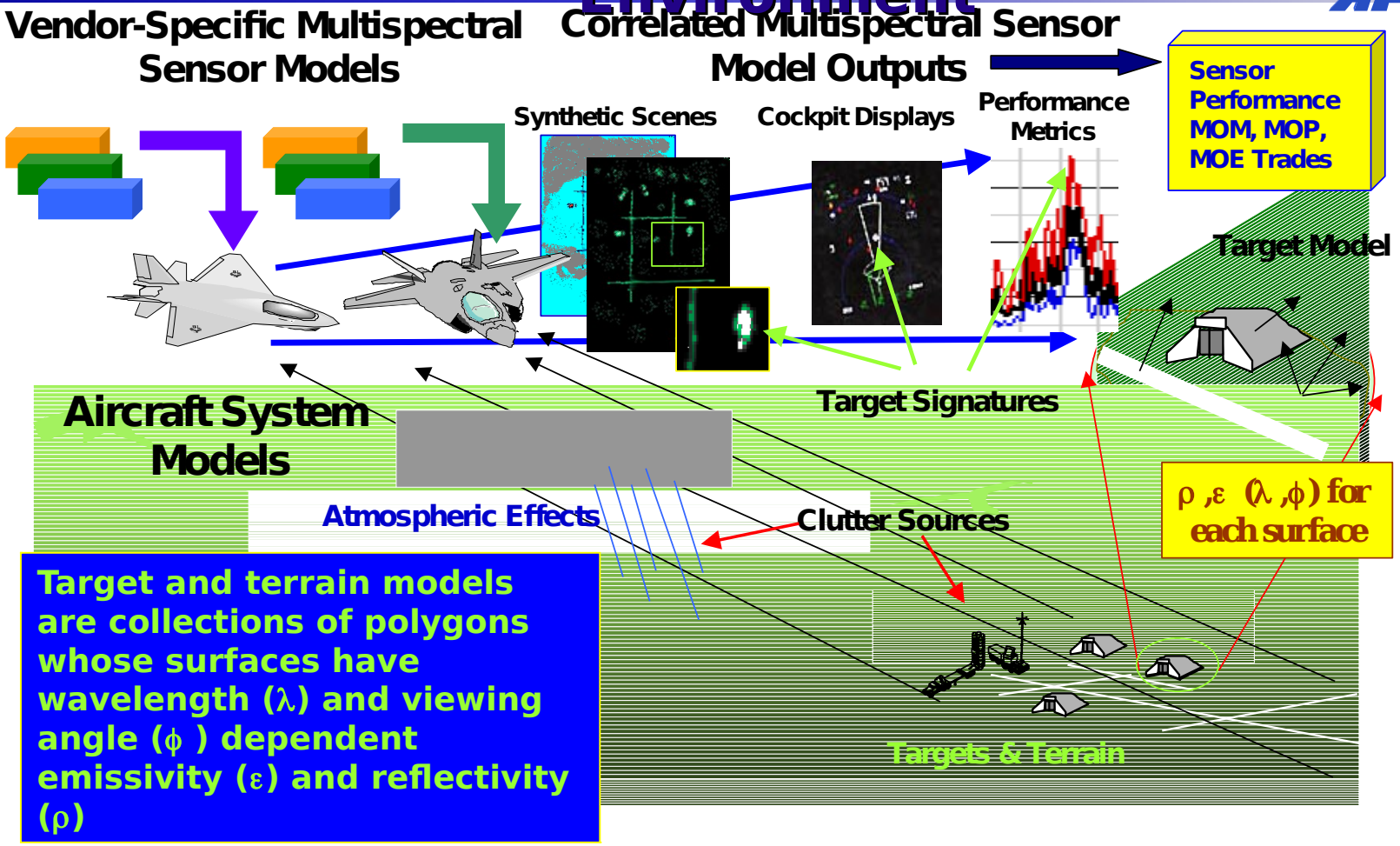
Multispectral Sensor Systems Require a Physics-Based Synthetic Environment

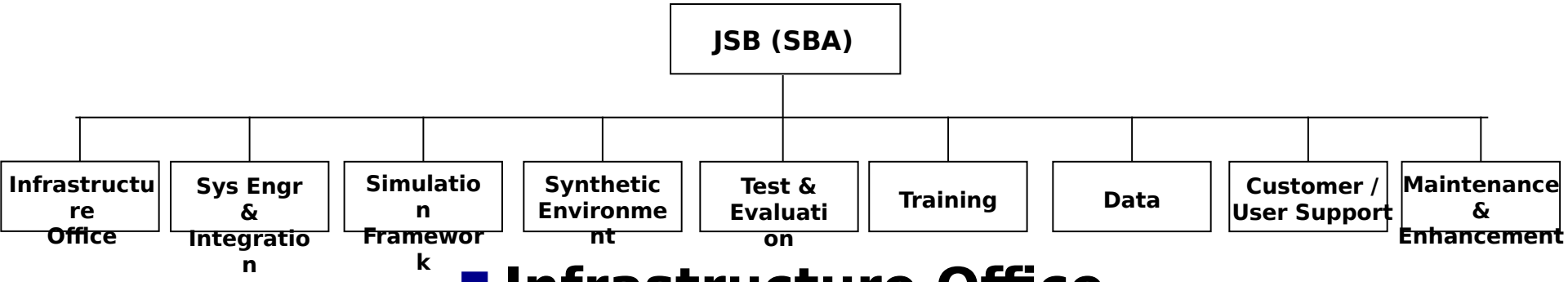

Vendor-Specific Multispectral Sensor Models
Correlated Multispectral Sensor Model Outputs
Sensor Performance MOM, MOP, MOE Trades
Synthetic Scenes
Cockpit Displays
Performance Metrics
Target Model
Aircraft System Models
Target Signatures
ρ ,ε (λ ,ϕ) for each surface
Atmospheric Effects
Clutter Sources
Target and terrain models are collections of polygons whose surfaces have wavelength (λ) and viewing angle (ϕ) dependent emissivity (ε) and reflectivity (ρ)
Targets & Terrain

Synthetic Environment At-Sensor Radiance/Reflectance -- Function of Wavelength, Terrain/Atmosphere Geophysics, Target Physics, Season, ...

Development Approach

- **Document Need and Requirements**
  - Mission Need Statement
  - Concept of Operations
  - Operational Concept Description
  - System/Subsystem Specification
- **Develop Notional Architecture**
  - System/Subsystem Design Document
  - Architecture Views – Operational, System, Technical
- **Assign Effort to Collaborative Team**
  - Weekly JSB Architecture IPT Meetings

JSB (SBA) Level One and Two
Work Breakdown Structure (WBS)



- Infrastructure Office
- Systems Engineering & Integration
- Simulation Framework
- Synthetic Environment
- Test & Evaluation
- Training
- Data
- Customer / User Support
- Maintenance & Enhancement

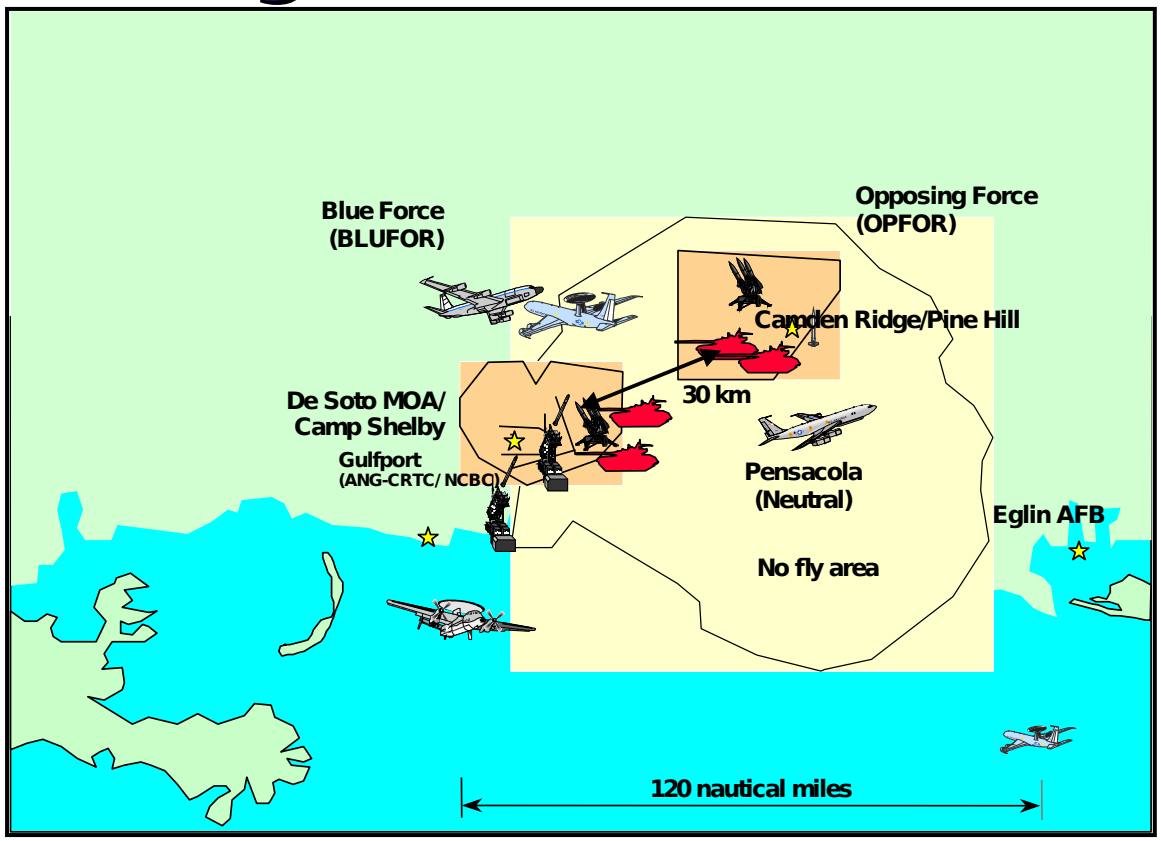
JSB (SBA) Development Timeline

- **FY01**
  - CONOPS
  - User Reqs
- **FY02**
  - Operational Concept Document
  - System Reqs SSS
  - Architecture SSDD
  - Experimentation
    - JSB (SBA) JCIET Validation
  - Analysis -- MC2C
- **FY03**
  - Spiral 1.0 Capability (Dev)
  - Experimentation/Analysis
- **FY04**
  - Spiral 2.0 Capability (Dev)
  - Experimentation/Analysis
- **FY05**
  - Spiral 3.0 Capability (Dev)
  - Experimentation/Analysis
- **FY06**
  - Spiral 4.0 Capability (Dev)
  - Experimentation/Analysis
- **FY07**
  - Spiral 5.0 Capability (Dev)
  - Experimentation/Analysis
- **FY08**
  - O&M
  - Technology Upgrades
  - Experimentation/Analysis
- **FY09**
  - O&M
  - Technology Upgrades
  - Experimentation/Analysis

DRAFT

Spring 02 JSB Experiment Prototype, Validate, Gain Insight

- JCIET/JC2ISR 2002 to Evaluate TCT, CAS, C2ISR, Deep & Close Targets
- 4,000 Participants
  - Joint & Coalition
- JC2ISR JT&E Concurrent
- Over 300 Vehicles
  - Fully instrumented
- Live Fly 15-26 April 2002
- Validate Synthetic Environment with Live-fly Data in Vegetated Scenario
- Mission Rehearsal Application



- **Challenge -- Leveraging Activities and Funding from Potential Sources to Build Synthetic Environment and Perform Verification and Validation**

Key Milestones

- Nov, JSB Concept of Operations
- 3-4 Jan, FOM-a-rama
- 24 Jan, JRWG #3 – Monthly
- Jan, Draft Operational Concept Description
- Mar, System Subsystem System
- 19-26 Apr, JCIET Event
- 15 May, JCIET Data
- 30 May, Accreditation Letter/Package
- 2 Jul, Analysis Report
- 29 Jul, Experiment Final Report
- Jul, System Subsystem Design Document

Experiment

Background

- **How Experiment Fits into Overall JSB (SBA) Effort**
  - Prototype Federation to Elicit JSB (SBA) Requirements
  - Proof of Concept wrt providing a high fidelity common synthetic environment to service battlespace entities
- **What's Different about the Experiment**
  - Common Synthetic Environment driving three separate sensor simulations on the Rivet Joint, JSTARS, UAV, and F-15E platforms
  - Traversing mixed mode Synthetic Environment -- integration of high fidelity "postage stamp" into JCIET low fidelity play box
  - Mixed resolution wrt physics based models of the three separate sensor simulations -- Profit, ACS, and PRISM

Experiment Goals

- **Leverage Existing Capabilities (Reuse) …**
  - Minimize New Development -- Models and Environment
  - Integrate Best of Breed AF Simulations and Environments
- **Team Effort (Collaboration) …**
  - Labs, Product Centers, and Industry Partners
- **Build on JCIET 2002 Event**
  - Replicate *As-Is* Scenario/Vignette Where Possible …
  - Identify Challenges in Migrating to *To-Be* Architecture
- **Address Fundamental JSB (SBA) Questions**
  - "Why JSB (SBA) -- What Are the Discriminators"
  - Engineering Issues That Stress the Simulation and Challenge the Synthetic Environment
- Employ Real World C2ISR Displays, Where Possible

Experiment Objectives

JSB Experiment Federation

- Execute in (near) Real-time, as needed
- Immerse … Under Realistic Conditions
- Provide Repeatable Simulations …
- Use Existing / Legacy M&S …
- Use Physics-based Representations
- Use Existing C2ISR Systems in Federation …

Spring '02 Experiment Processes

- Demonstrate Collaborative Development
- Demonstrate Federation Validation Process
- Understand Processes to Define Data for Collection
- Use Existing C2ISR Systems for Scenario Planning (e.g., ATO)

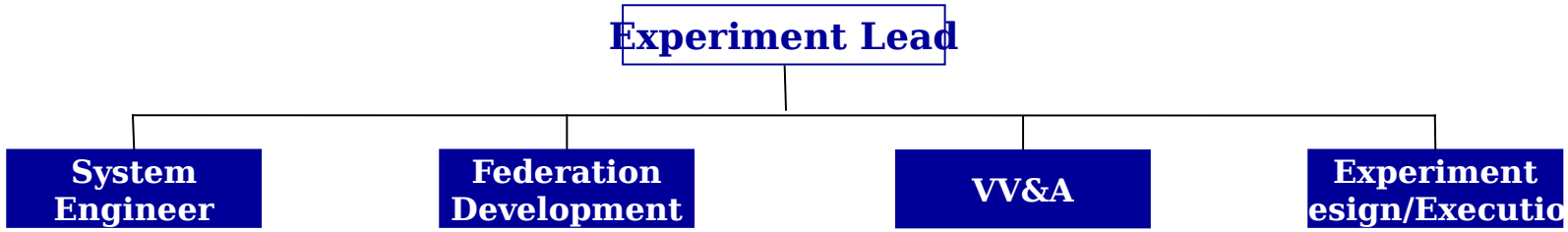
JSB Experiment Outcomes

- Demonstrate Discriminating Value-added of JSB Capabilities
- Use of JSB Experiment Federation to
  - Identify JSB (SBA) System Requirements
  - Identify Higher Fidelity Synthetic Environment Requirements for Advanced Sensors
- Gain Insight into JSB Technical Challenges and Risks
  - Identify Implementation and/or Technology Trade-offs
- Demonstrate Expansion to GSTF (F-22 ATR, UAV Excursions)
- Demonstrate Relevance to an Air Force Objective
- Perform One (Significant and Representative) Use Case for JCIET Test Rehearsal
- Predict Technical Performance Area(s) for Investigation During JCIET 02

MOEs/MOPs

- **Probability of Detection for Three Base Cases**
  - Clear and Visibility Unlimited
  - Partial Obscuration
  - Fully Obscured
- **Time of Detection for Three Base Cases**

Experiment Team



Experiment Lead
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JSB System Engineer
Toni Shetler, TRW/Systems
Subject Matter Expert (SME)
John Kogut, Eidea Labs
VV&A)
Gerald Prichard, Dynetics
Test Director
Jeff Wallace, Envoy
Configuration Manager
TBD

Federation Design
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Federation Implementation
Phil Landweer, BWB
Environment Developer, DMSO
George Lukes, Bob Clover, IDA
Federate Developers
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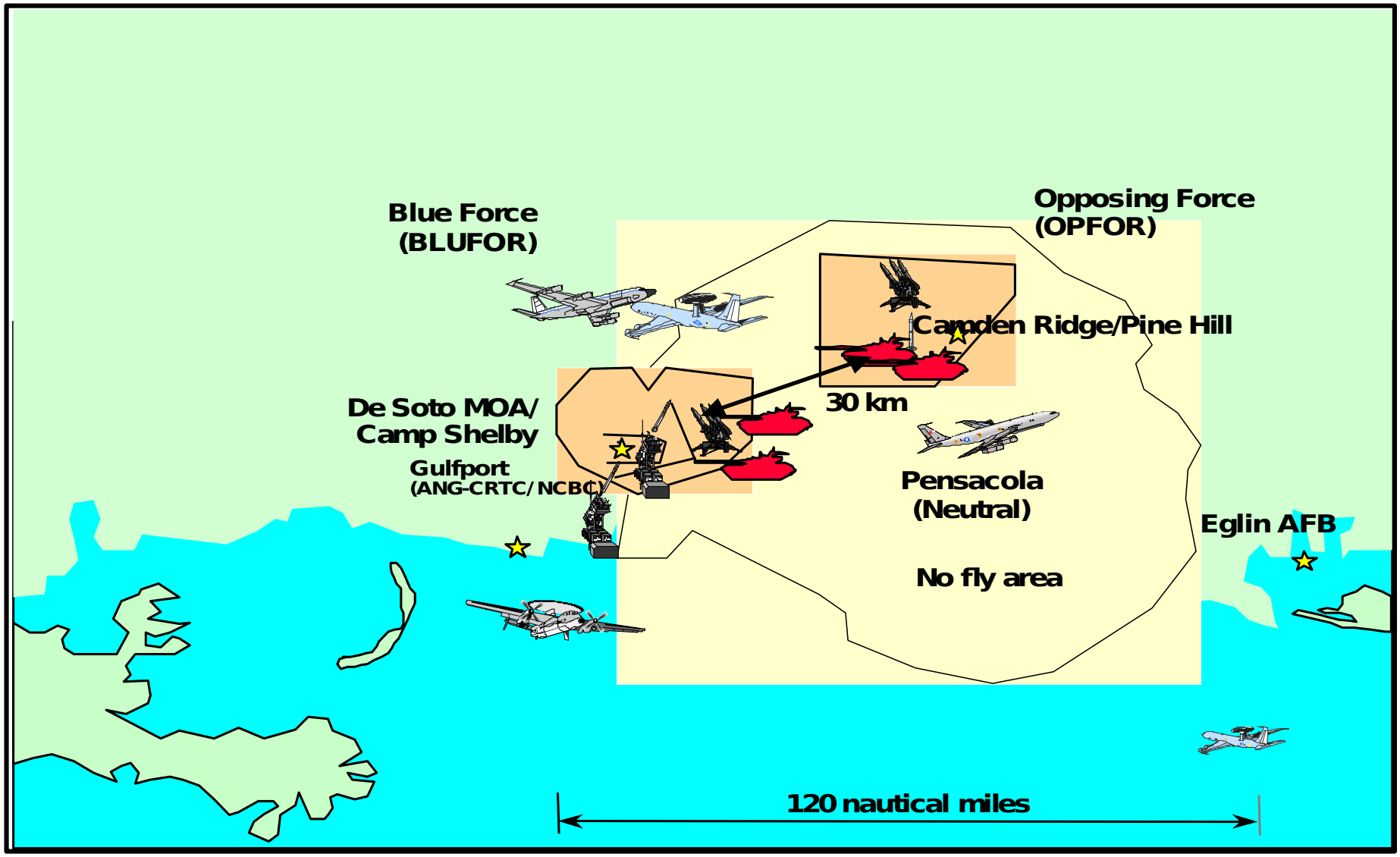
Andy Bevilacqua, BCR Technologies
Warren Katz, MaK Technologies
Russ Moulton, JRM Technologies
Steve Outz et al, NG/IT
Paul Sheridan, Ron Painter, CACI
Judy Sollenberger et al, LM-MFC
Dick Worsham et al, NG (Baltimore)

JSB Experiment Scenario/Vignette Overview



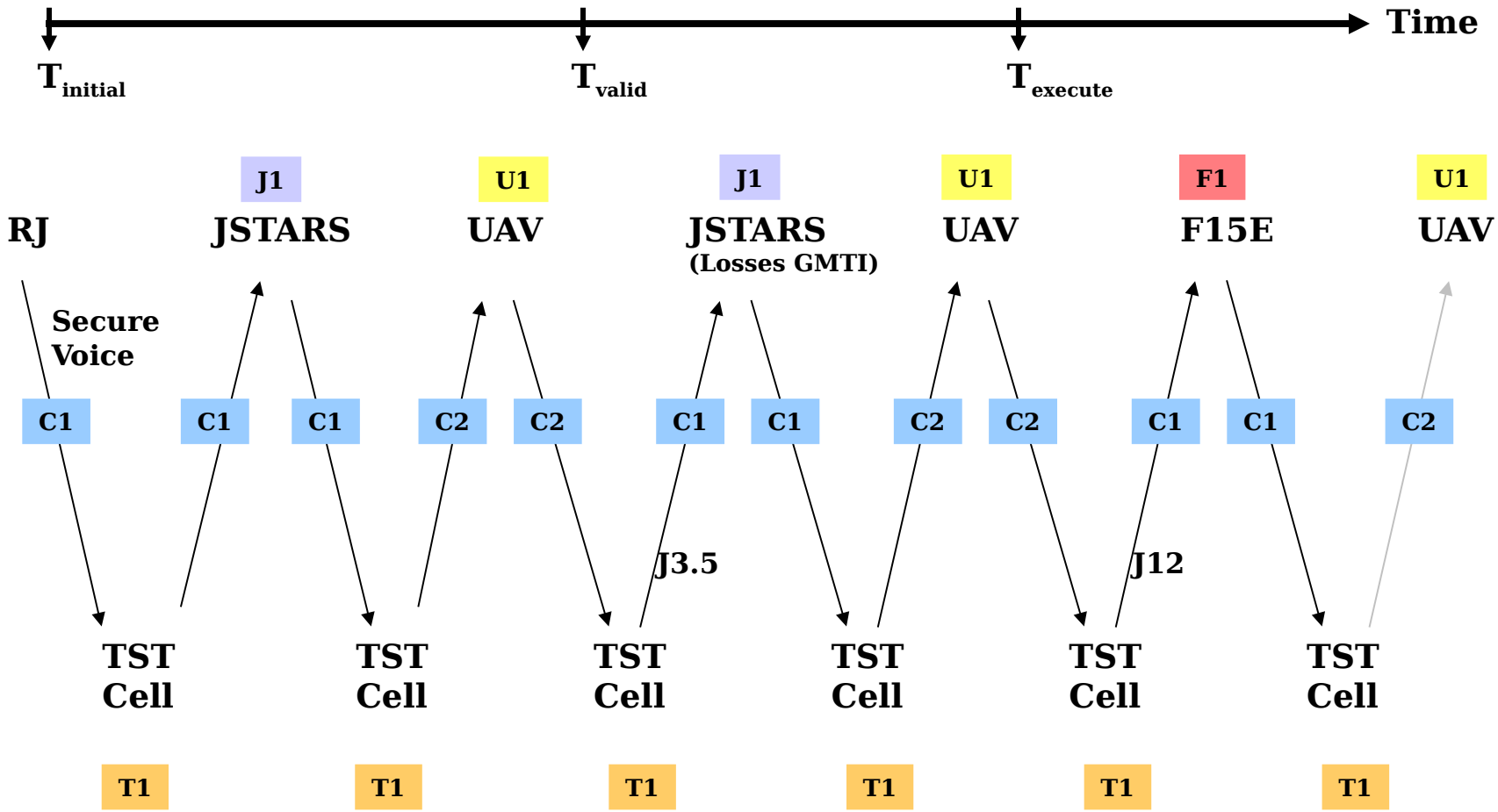
Scenario Overview

- **Rivet Joint (RJ) detects a SIGINT hit.**
  - RJ computes target ellipse location
  - RJ contacts Time Sensitive Targeting (TST) Cell (TSTC) and passes target type and coordinates
- **TST Cell directs Joint Stars (JSTARS) to investigate**
  - TST Cell begins target validation process
  - TST Cell identifies possible strikers for target
- **JSTARS detects movers at location passed by RJ**
  - JSTARS detects movers along line of communication (LOC)
  - Based on previous intel and where detected, confirms RJ's initial target type identification
- **TST Cell tasks UAV to monitor target**
  - UAV locates target with EO sensor
  - UAV passes its assessment of target type to TST Cell
  - TST Cell completes its target validation process with the data passed by the UAV
- **TST Cell initiates J3.5 message on the JTIDS net on the target in question**
  - TST Cell contacts the AOC which contains the JTIDS ground station with J3.5 info
  - TST Cell confirms the appearance of the new ground target on the JTIDS net

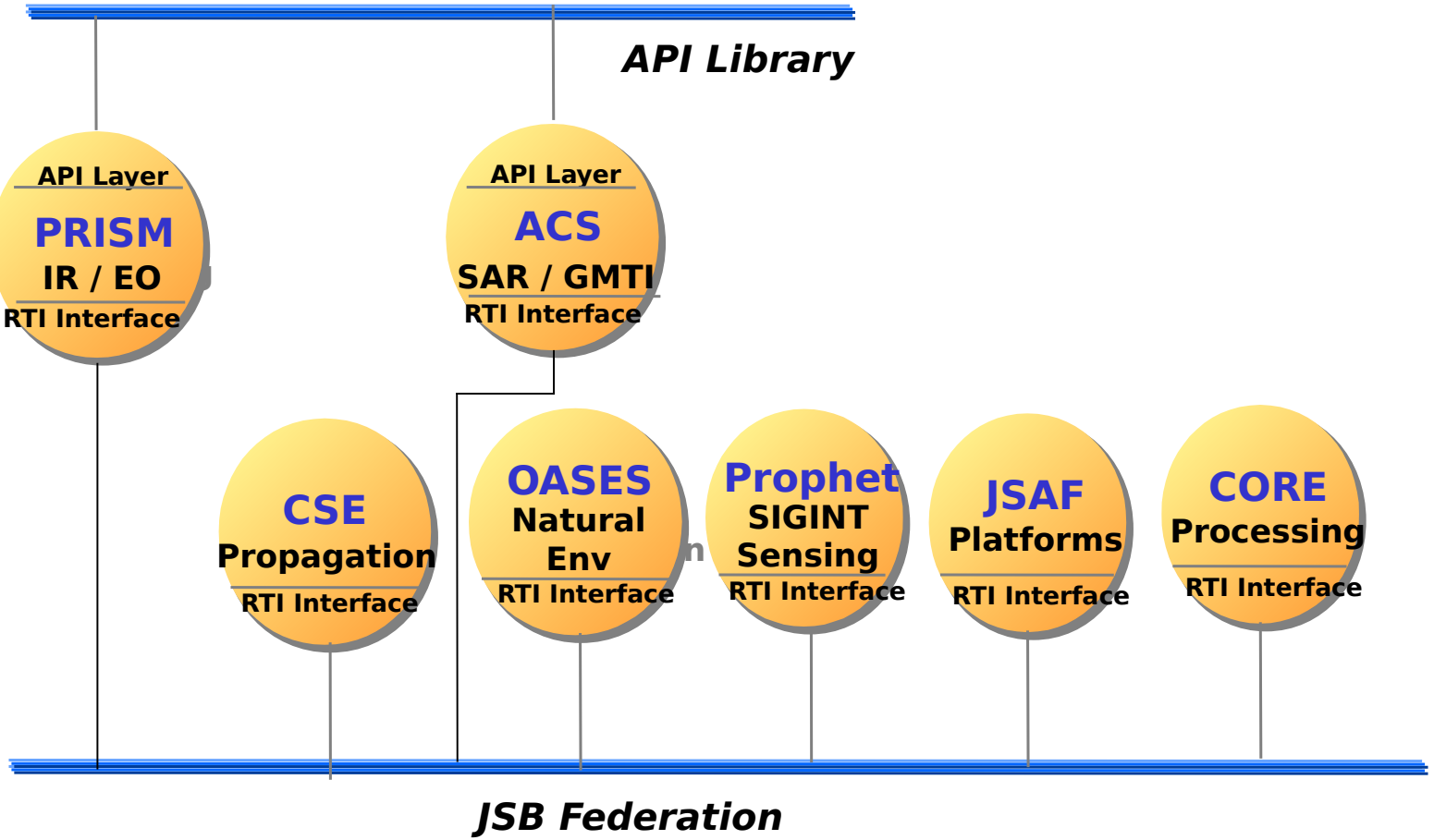
Scenario Overview (cont'd)

- **JSTARS loses GMTI track on the target in question**
  - Target stops moving
  - Target stop could indicate it is preparing to "shoot"
- **TST Cell retasks UAV to target's last known position**
  - UAV finds target
  - UAV passes to TST Cell target location and its activity
  - UAV continues to monitor target
- **TST Cell issues J12.0 message (execution message) to F-15E strikers**
  - If JTIDS is unavailable TST Cell passes message to strikers via voice
  - TST Cell passes on to strikers any other pertinent info about targets (9 Line type info)
- **F-15Es prosecute target attack**
  - F-15E executes a SAR map of the target area
  - F-15E finds target on SAR map and refines target coordinates
  - F-15E cues the LANTIRN targeting pod to updated coordinates
  - F-15E locates and IDs target in LANTIRN
  - F-15E chooses best weapon to engage target (CBU or GBU-12)
  - F-15E releases weapons and sees target impact on LANTIRN
- **TST Cell Re-Tasks UAV for BDA**

JSB Experiment Sequence Diagram



Federation Architecture



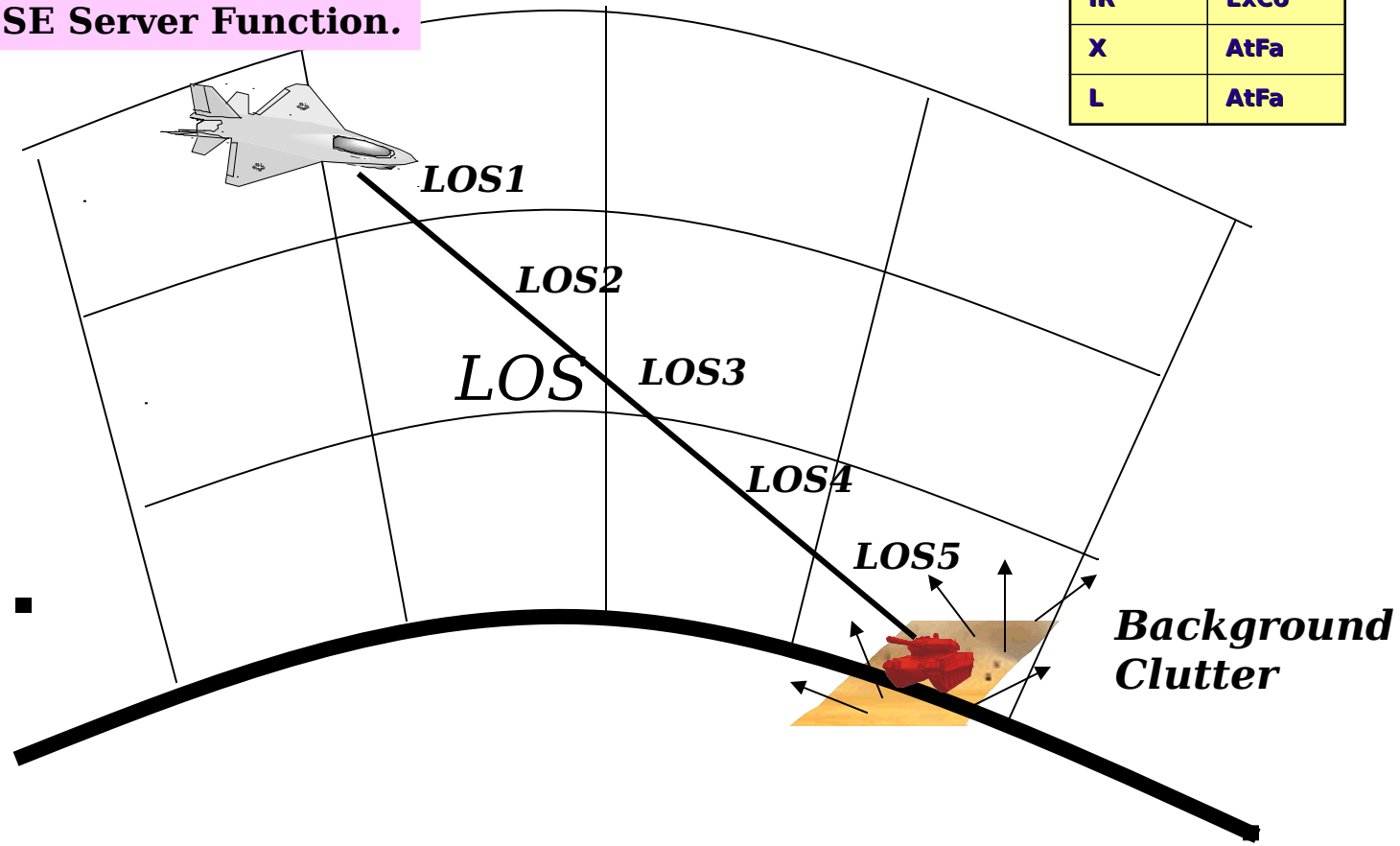
Example

Total Atmospheric Effect Following LOS = Σ Atmospheric Effect of LOS_i Segment

Weather (Hum, Temp, Wind Extinction Coefficient

EO	ExCo
IR	ExCo
X	AtFa
L	AtFa

The above is a part of Common SE Server Function.



Summary

- **JSB Being Developed to Provide "Cradle to Grave" Weapon System Analysis Capability for the Most Complex Systems (of Systems) Analysis Problems – i.e., C4ISR**
- **JSB Spring Experiment Will Allow Insight Into JSB (SBA) Requirements, System Architecture, and Needed Technology**
- **JSB Will Support Many Near Term Air Force System Acquisition Challenges**
  - **Interoperability (JDEP)**
  - **MC2C**
  - **SBR**
  - **SIAP**
  - **…**